IBM System Networking RackSwitch G8124E

IBM Redbooks Product Guide

The IBM® System Networking RackSwitch™ G8124E delivers exceptional performance that is both lossless and low latency. In addition, the G8124E delivers excellent cost savings as you consider acquisition costs, energy costs, plus its feature-rich design with when it comes to virtualization, CEE/FCoE, high availability, and its enterprise class Layer 2 and Layer 3 functionality.

With support for 1G or 10G, this switch is designed for those clients that are leveraging 10G Ethernet today or have plans to in the future. This is the first Top of Rack 10Gb switch for IBM System x® designed to support IBM Virtual Fabric, which helps clients significantly reduce cost and complexity when it comes to the I/O requirements of most virtualization deployments today. Virtual Fabric can help clients reduce the number of multiple I/O adapters down to a single dual-port 10G adapter, in addition to reducing the number of cables and upstream switch ports required. Virtual Fabric allows clients to carve up a dual-port 10G adapter into eight virtual NICs (vNICs) and create dedicated virtual pipes between the adapter and the switch for optimal performance, plus higher availability and better security. This functionality provides the ability to dynamically allocate bandwidth per vNIC in increments of 100 Mb, while being able to adjust over time without downtime. Figure 1 shows the IBM System Networking RackSwitch G8124E.

Figure 1. IBM System Networking RackSwitch G8124E

Did you know

- The G8124E switch is designed to support a number of separate types of configurations from a server or downstream switches: 1 Gb, 10 Gb, virtual NIC, Converged Enhanced Ethernet (CEE/FCoE), and iSCSI. This single switch can handle all these workloads and can connect to an upstream 1 Gb or 10 Gb infrastructure, or both.
- The G8124E is designed to support data center bridging (DCB), which is the IEEE's group of protocols that provide Lossless Ethernet and allows for clients to reduce the costs of implementing FCoE by leveraging port aggregation before connecting to more costly upstream gateway devices.
- IBM Virtual Fabric helps clients reduce costs and complexity in environments where they need four or more NICs per server. A perfect example is virtualization, where clients often need as many as eight NICs per server.
- IBM is a leader in helping clients reduce the complexity of managing VMs and VM migration with their IBM VMready® product, which makes the network VM aware.

Part number information

Tables 1 and 2 list IBM System x® part numbers and IBM Power Systems™ MTMs and Feature Codes for ordering the modules and additional options. Small form-factor pluggable plus (SFP+) and SFP transceivers are not included.

Table 1. IBM part numbers and feature codes for ordering

Description	System x part number	Power Systems MTM/FC
IBM System Networking RackSwitch G8124DC	7309BD5	
IBM System Networking RackSwitch G8124E (Rear-to-Front)	7309BR6	1455-24E
IBM System Networking RackSwitch G8124E (Front-to-Rear)	7309BF7	
1 Gb options		
IBM SFP RJ45 Transceiver	81Y1618	EB29
IBM SFP SX Transceiver	81Y1622	EB2A
IBM SFP LX Transceiver	90Y9424	ECB8
0.6 m Blue Cat5e Cable	40K5679	ECB0
1.5 m Blue Cat5e Cable	40K8785	ECB2
3 m Blue Cat5e Cable	40K5581	1111
10 m Blue Cat5e Cable	40K8927	1112
25 m Blue Cat5e Cable	40K8930	1113
10 Gb options		
IBM SFP+ SR Transceiver	46C3447	EB28
IBM SFP+ LR Transceiver	90Y9412	ECB9
IBM SFP+ ER Transceiver	90Y9415	ECBA
1 m IBM Active DAC SFP+ Cable	95Y0323	EN01
3 m IBM Active DAC SFP+ Cable	95Y0326	EN02
5 m IBM Active DAC SFP+ Cable	95Y0329	EN03
0.5 m IBM Passive DAC SFP+ Cable	00D6288	ECBG
1 m IBM Passive DAC SFP+ Cable*	90Y9427	ECB4
3 m IBM Passive DAC SFP+ Cable*	90Y9430	ECB5
5 m IBM Passive DAC SFP+ Cable*	90Y9433	ECB6
7 m IBM Passive DAC SFP+ Cable*	00D6151	ECBH

* Passive cables not supported for Power Systems 10Gb NICs. Used for switch to switch connectivity only.

Table 2 lists IBM part numbers and feature codes for ordering miscellaneous options.

Table 2. IBM part numbers and feature codes for ordering miscellaneous options

Description	System x part number	Power Systems MTM/FC
IBM System Networking Adjustable 19" 4 Post Rail Kit	00D6185	EU27
1 m LC-LC Fiber Cable (networking) - Optical	88Y6851	ECBC
5 m LC-LC Fiber Cable (networking) - Optical	88Y6854	ECBD
25 m LC-LC Fiber Cable (networking) - Optical	88Y6857	ECBN

With the flexibility of the G8124E switch, clients can take advantage of the technologies that they require for multiple environments. For 10 Gb uplinks, they have a choice of either SFP+ transceivers (SR or LR) for longer distances or more cost-effective and lower-power-consuming options such as SFP+ direct-attached cables (DAC or Twinax cables), which can be 1 - 8.5 meters in length and are ideal for connecting chassis together, connecting to a Top of Rack switch, or even connecting to an adjacent rack.

The G8124E module part numbers include the following items:

- One IBM System Networking RackSwitch G8124E
- Generic Rail Mount Kit (2-post)
- IBM System Networking RackSwitch Mini-USB to DB9 serial cable (3 m)
- IBM limited 3-year hardware warranty with Next Business Day (NBD), 9x5, Customer Replaceable Unit (CRU) warranty service

Models shipped after April 5, 2011 include a 3-year software license, providing entitlement to upgrades over that period.

Power cables need to be ordered separately at no additional charge. Table 3 and Table 4 list these options.

Table 3. Additional cables to be ordered separately for System x

Part number	Description
39Y7917	Power Cord Europe AC plug 10A/250 V; OPT
39Y7918	Power Cord Europe (Denmark) AC plug 10A/250 V; OPT
39Y7919	Power Cord Europe (Switzerland) AC plug 10A/250 V; OPT
39Y7920	Power Cord Europe (Israel) AC plug 10A/250 V; OPT
39Y7922	Power Cord Europe (South Africa) AC plug 10A/250 V; OPT
39Y7923	Power Cord UK AC plug 13A/250 V; OPT
39Y7924	Power Cord Australia AC plug 10A/250 V; OPT
39Y7925	Power Cord Korea AC plug 10A/250 V; OPT
39Y7926	Power Cord Japan AC plug 10A/250 V; OPT
39Y7927	Power Cord India AC plug 10A/250 V; OPT
39Y7928	Power Cord China AC plug 16A/250 V; OPT
39Y7929	Power Cord Brazil AC plug 16A/250 V; OPT
39Y7930	Power Cord Uruguay/Argentina AC plug 16A/250 V; OPT
39Y7931	Power Cord US/Canada AC plug 10A/250 V; OPT

Table 4. Power cords description with IBM Power System and Storage Feature Codes

Description	Feature Code
Power Cord 4.3m (14-ft), Drawer to Wall/IBM PDU (250V/10A)	6458
Power Cord 4.3m (14-ft), Drawer to Wall/OEM PDU (250V/15A) U. S.	6469
Power Cord 1.8m (6-ft), Drawer to Wall (125V/15A)	6470
Power Cord 2.7m (9-ft), Drawer to Wall/OEM PDU (125V/15A)	6471
Power Cord 2.7m (9-ft), Drawer to Wall/OEM PDU (250V/16A)	6472
Power Cord 2.7m (9-ft), Drawer to Wall/OEM PDU (250V/10A)	6473
Power Cord 2.7m (9-ft), Drawer to Wall/OEM PDU, (250V/13A)	6474
Power Cord 2.7m (9-ft), Drawer to Wall/OEM PDU, (250V/16A)	6475
Power Cord 2.7m (9-ft), Drawer to Wall/OEM PDU, (250V/10A)	6476
Power Cord 2.7m (9-ft), Drawer to Wall/OEM PDU, (250V/16A)	6477
Power Cord 2.7m (9-ft), Drawer to Wall/OEM PDU, (125V/15A or 250V/10A)	6488
Power Cord 2.7m (9-ft), Drawer to Wall/OEM PDU, (250V/10A)	6493
Power Cord 2.7m (9-ft), Drawer to Wall/OEM PDU, (250V/10A)	6494
Power Cord 4.3m (14-ft), Drawer to Wall/OEM PDU (125V/15A)	6660
Power Cord 2.8m (9.2-ft), Drawer to Wall/IBM PDU, (250V/ 10A)	6665
Power Cord 2.7m (9-ft), Drawer to Wall/OEM PDU, (250V/10A)	6680
Power Cord 2.7m (9-ft), Drawer to Wall/OEM PDU, (250V/10A)	6671
Power Cord 1.5m (5-ft), Drawer to Wall/OEM PDU, (250V/10A)	6672

Benefits

The IBM System Networking RackSwitch G8124E offers the following benefits:

- **High performance**: The 10G Low Latency (as low as 570 nanoseconds) switch provides the best combination of extremely low latency, non-blocking line-rate switching and ease of management.
- **Lower power and better cooling**: The G8124E uses as little power as two 60 W light bulbs, which is a fraction of the power consumption of most competitive offerings. Unlike side-cooled switches, which can cause heat recirculation and reliability concerns, the G8124E rear-to-front cooling design reduces data center air conditioning costs by having airflow match the servers in the rack. In addition, variable speed fans assist in automatically reducing power consumption.
- **Virtual Fabric** can help customers address I/O requirements for multiple NICs while also helping reduce cost and complexity. Virtual Fabric for IBM allows for the carving up of a physical NIC into multiple virtual NICs (2 - 8 vNICs) and creates a virtual pipe between the adapter and the switch for improved performance, availability, and security while reducing cost and complexity.
- **VM aware Networking**: VMready software on the switch helps reduce configuration complexity while significantly improving security levels in virtualized environments. VMready automatically detects virtual machine movement from one physical server to another, and instantly reconfigures each VM's network policies across VLANs to keep the network up and running without interrupting traffic or impacting performance. VMready works with all leading VM providers such as VMware, Citrix, Xen, IBM PowerVM®, and Microsoft.

- **Layer 3 functionality**: The switch includes Layer 3 functionality, which provides security and performance benefits as inter-VLAN traffic stays within the chassis. This switch also provides the full range of Layer 3 protocols from static routes for technologies such as Open Shortest Path First (OSPF) and Border Gateway Protocol (BGP) for enterprise customers.
- **Seamless Interoperability**: IBM switches interoperate seamlessly with other vendors' upstream switches. For more information, see Tolly Reports: Tolly Functionality and Certification: RackSwitch G8000 and G8124 and Cisco Catalyst Interoperability Evaluation. For more information, visit the following website:

  http://ibm.co/ZRwiR0

- **Fault tolerance**: These switches learn alternate routes automatically and perform faster convergence in the unlikely case of a link, switch, or power failure. The switch uses proven technologies, such as L2 trunk failover, advanced VLAN-based failover, VRRP, HotLink, Uplink Failure Detection (UFD), IGMP V3 snooping, and OSPF.
- **Converged fabric**: The switch is designed to support CEE/DCB and connectivity to FCoE gateways. CEE helps enable clients to combine storage, messaging traffic, VoIP, video, and other data on a common data center Ethernet infrastructure. FCoE helps enable highly efficient block storage over Ethernet for consolidating server network connectivity. As a result, clients can deploy a single server interface for multiple data types, which can simplify both deployment and management of server network connectivity, while maintaining the high availability and robustness required for storage transactions.
- **Transparent networking capability**: With a simple configuration change to Easy Connect mode, the RackSwitch G8124E becomes a transparent network device, invisible to the core, eliminating network administration concerns of Spanning Tree Protocol configuration/interoperability, VLAN assignments and avoids any possible loops.

  By emulating a host NIC to the data center core, it accelerates the provisioning of VMs by eliminating the need to configure the typical access switch parameters.

Features and specifications

The following sections list the features and specifications.

Performance

The performance specifications are:

- 100% line rate performance
- Latency of 570 nanoseconds
- 480 Gbps non-blocking switching throughput (full duplex)

Hardware features

Features are listed for the following models:

- IBM System Networking RackSwitch G8124DC (DC Power): IBM PN 7309CD9
  Rear-to-front airflow is ideal for servers or blade chassis with ports in back of rack.

Features are also listed for the enhanced models:

- IBM System Networking RackSwitch G8124E (Rear-to-Front): IBM PN 7309BR6 or MTM 1455-24E

  Rear-to-front airflow is ideal for servers or blade chassis with ports in back of rack.
- IBM System Networking RackSwitch G8124E (Front-to-Rear): IBM PN 7309BF7

  Front-to-rear airflow is ideal for IBM iDataplex or when needing ports in front of rack.

Hardware features are as follows:

- Interface options
  - Twenty-four 10G SFP+ Ethernet ports
  - 2x 10/100/1000 Ethernet RJ45 ports for Management
  - One mini-USB Console port for management
  - Server-like port orientations, enabling short and simple cabling
  - Active DAC support for interoperability with Cisco Nexus 5k and Brocade
- Dimensions: 17.3” wide, 15” deep, 1 RU high
- Weight: 6.40 kg (14.08 lb)
- Rack Installation Kit
  - Generic Rail Mount Kit (2-post)
  - Optional IBM System Networking Adjustable 19" 4 Post Rail Kit
- LEDs
  - System LEDs to indicate status
  - LEDs to indicate master/member
- Airflow
  - Rear-to-front or front-to-rear cooling
  - Redundant variable speed fans for reduced power draw
- Power
  - The AC-powered G8124E has dual load-sharing internal power modules, 50 - 60 Hz, 100 - 240 VAC auto-switching per module.
  - The DC-powered G8124E has dual load-sharing internal -48 V DC power supplies, input voltage ranging from 42 V dc to 60 V dc per module.
  - The nominal power for the G8124E ranges from 115 W to 168 W depending on the speed of the port (1G/10G), type of transceivers (SR or DAC), and number of active ports.
- Mean time between failures (MTBF): 189,060 hrs with ambient operating temperature of 40ºC MTBF is calculated using the Telcordia Technologies Reliability Prediction Procedure for Electronic Equipment (SR-332 issue 2), Parts Count (method 1 case 1) failure rate data.
- Environmental specifications
  - Temperature: ambient operating: 0º C to +40º C
  - Relative humidity: non-condensing, operating 10 to 90%
  - Altitude: operating 2000 m (6561 feet)
  - Acoustic noise: less than 65 dB
  - Heat dissipation: 1100 BTU/hour (maximum)

For the most current updates, see the IBM Networking Operating System data sheet at: http://ibm.biz/Bdx4gn

Software features

Software features are as follows:

- Security
  - RADIUS
  - TACACS+
  - SCP
  - Wire speed filtering: allow and deny
  - SSH v1, v2
  - HTTPS Secure BBI
  - Secure interface login and password

    - MAC address move notification
    - Shift B Boot menu (password recovery/factory default)
- VLANs
    - Port-based VLANs
    - 4096 VLAN IDs supported
    - 1 k VLANs (802.1Q)
    - Private VLAN Edge
- FCoE/Lossless Ethernet
    - 802.1 Data Center Bridging
    - Priority-based Flow Control (PFC)
    - Enhanced Transmission Selection (ETS)
    - Data Center Bridge Exchange protocol (DCBX)
    - FIP Snooping
    - Fibre Channel over Ethernet
    - Converged Enhanced Ethernet
- Trunking
    - LACP
    - Static Trunks (EtherChannel)
    - Configurable Trunk Hash algorithm
- Spanning Tree
    - Multiple Spanning Trees (802.1s)
    - Rapid Spanning Tree (802.1w)
    - PVRST+
    - Fast Uplink Convergence
    - BPDU guard
- Quality of service
    - QoS 802.1p (priority queues)
    - DSCP remarking
    - Metering
- Routing protocols
    - RIP v1/v2
    - OSPF
    - BGP
- High availability
    - Uplink failure detection
    - HotLinks
    - Virtual Router Redundancy support (VRRP)
    - Active MultiPath (AMP)
- Multicast
    - IGMP Snoopingv1, v2, and v3 with 2 K IGMP groups
    - Protocol Independent Multicast (PIM sparse mode/dense mode)
- Monitoring
    - Port mirroring
    - ACL-based mirroring
    - sFlow Version 5
- Virtualization
    - VMready with VI API support
    - vNIC MIB support for SNMP Management features
    - Netboot
- Clients
    - System Networking Switch Center (SNSC)
    - isCLI (Cisco-like)
    - Scriptable CLI
    - Browser-based client or Telnet
- Standard protocols
    - IPv6
    - SNMP v1, v2c, and v3
    - RMON
    - Secondary NTP support
    - Accept DHCP
    - DHCP Relay

    - LLDP
    - 16 K MAC table
    - 9 K jumbo frames
    - 802.3X flow control
- Upgrades
    - Upgrade firmware via serial or TFTP
    - Dual software images

Popular configurations

The following sections describe popular configurations.

Virtual Fabric configuration

IBM Virtual Fabric for IBM System x is built using industry standards and is an ideal solution for customers that require more than two NICs per server. Over the past couple of years many clients have seen their I/O requirements per server increase anywhere from four to six to eight, or even more, NICs per server, especially with the adoption of virtualization. IBM Virtual Fabric allows clients the ability to use a virtual NIC approach using10G Ethernet technology to help reduce cost and complexity, and achieve better performance and more flexibility. For example:

- **Reduce costs**: (acquisition and operating) by using fewer adapters, cables, and upstream switch ports.
- **Reduce complexity**: Fewer items to manage, based on industry standards making thing easier to manage with the addition of high availability and better security.
- **Better performance**: Significantly more I/O bandwidth per server and lower latency than traditional 1G Ethernet.
- **Flexibility**: The ability to carve up a dual-port 10G adapter into 4 - 8 virtual NICs and create virtual pipes between the adapter and switch for higher availability and security. Not only can customers dynamically allocate I/O bandwidth to each virtual NIC, Virtual Fabric also provides the ability to change those allocations as needed. For example, a customer may have one configuration for workload during the day and another during the evenings. Virtual Fabric has the ability to make those changes on the fly without downtime.

IBM Virtual Fabric (Figure 2) is designed in partnership with Emulex. The components needed for this solution are as follows:

- Emulex 10Gb Virtual Fabric Adapter for IBM System x (for more information, see http://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/tips0762.html?Open)
- IBM System Networking RackSwitch G8124E

Figure 2. IBM Virtual Fabric Adapter topology

Rack-optimized server aggregation : 10-GbE attached rack servers

Aggregation and servers are as follows:

- Concentration of rack-optimized servers, for example:
  - IBM 1U or 2U servers with a 10G adapter installed
  - IBM BladeCenter® using any of the following modules in the chassis:
    - IBM BladeCenter 1/10Gb Uplink Ethernet Switch Module
    - IBM BladeCenter Virtual Fabric 10Gb Switch Module
    - 10Gb Ethernet Pass-Thru Module for IBM BladeCenter
  - IBM Flex System™ using any of the following Ethernet modules in the chassis:
    - IBM Flex System EN2092
    - IBM Flex System Fabric EN4093/EN4093R
- Low-profile, high-performance, 24-port 10-GbE switch needed to perform aggregation function per rack

Figure 3 shows a G8124E top-of-rack switch.

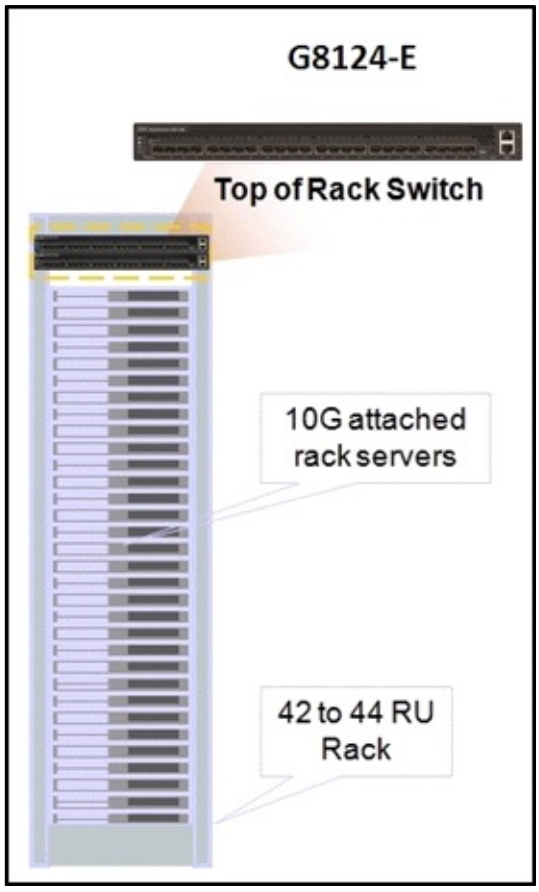

Figure 3. G8124E top-of-rack switch

Table 5 lists the features and benefits of the switch.

Table 5. Features and benefits

Features	Benefits
Line-rate, non-blocking, all 24-ports	Supports massive compute and virtualization workloads.
Less than 600 nano-second latency	Faster application response times.
Support for IGMP Snooping and L3 forwarding	Enables high-bandwidth, low-latency multicast applications.
Standards-based Layer 2/3 protocols, industry standard CLI	Interoperates with existing network. No learning curve.

Rack-optimized server aggregation logical design

The design goal is a G8124E (10GbE) switch at Distribution Layer and G8000 (1GbE) at Edge/Access (Figure 4):

- Logical configuration: Configure G8000s for Layer 2 and apply static routes for L3 forwarding.
- Full Layer 2/3 feature set: STP, MSTP, RSTP, PVRST+;RIP v1/2, static routes, OSPF.
- Security: 802.1X; RADIUS/TACACS+; Wire Speed ACLs, SSH v1, v2; HTTPS Secure BBI.
- QoS: Up to eight queues/port, IEEE 802.1p and DiffServ prioritization.

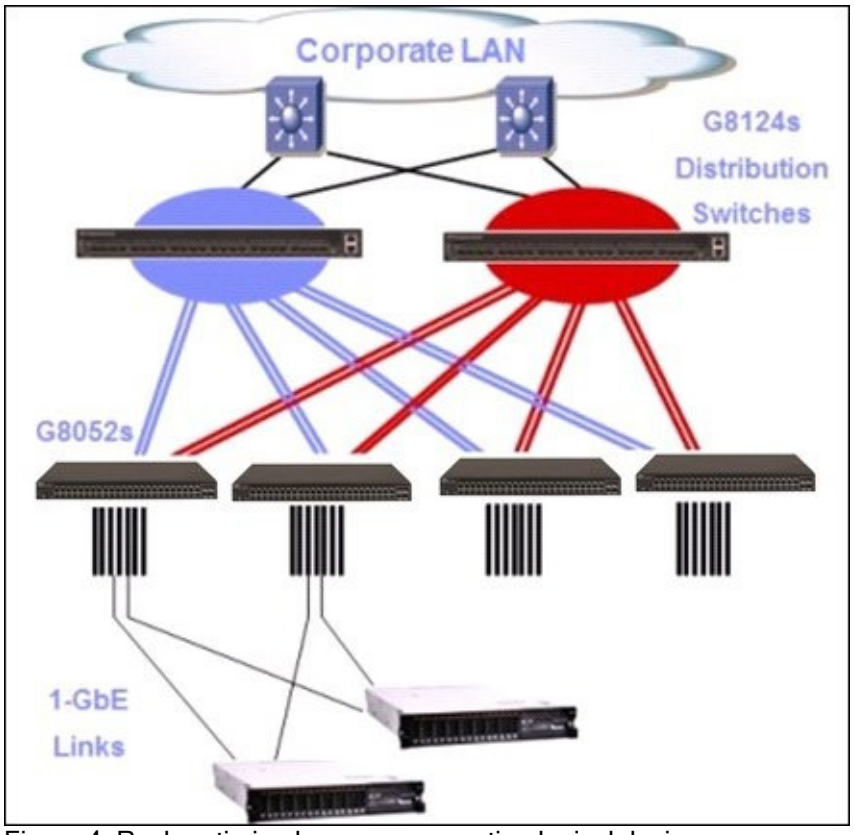

Figure 4. Rack-optimized server aggregation logical design

10-GbE departmental cluster or server aggregation (option 1–L2 Config.)

Figure 5 shows the 10-GbE departmental cluster or server aggregation. Design goals are as follows:

- Less than 600 ns port-to-port latency
- Link aggregation of trunk connections: IEEE 802.3ad
- No STP uplink failure detection (UFD) to enable redundant paths

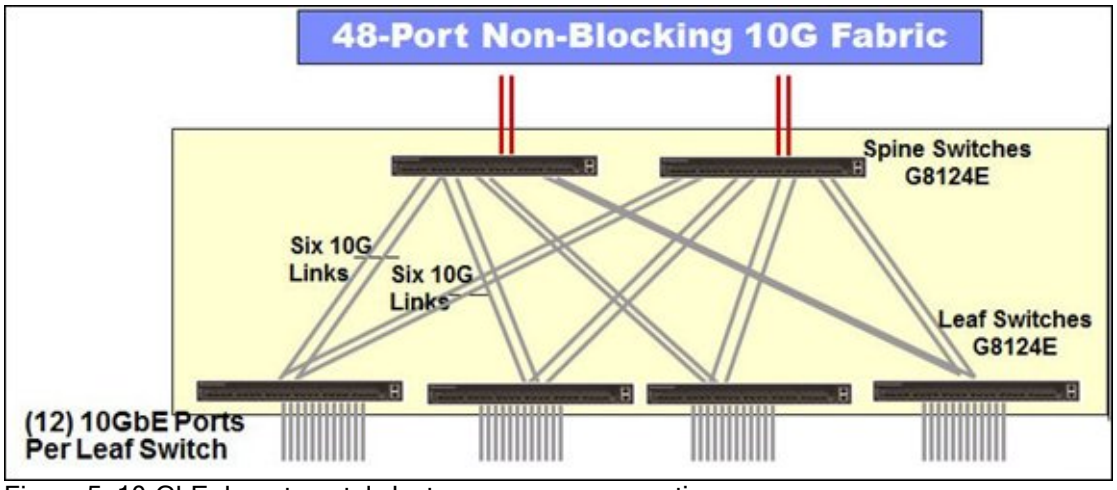

Figure 5. 10-GbE departmental cluster or server aggregation

Table 6 lists the items, descriptions, and quantities.

Table 6. Items, descriptions, and quantities

Item	Description	Quantity
Spine and leaf switches	G8124E	6
Interconnect cabling	SFP+ DAC	48

IP storage over 10-GbE: Changing the economics of storage

G8124E benefits for IP storage applications (Figure 6):

- Lossless Ethernet Fabric
- Ultra-low latency for time-sensitive disk reads/writes
- Line-rate, high-bandwidth performance
- Low power consumption with fewer components
- Low-cost, pay-as-you-grow 10G storage network

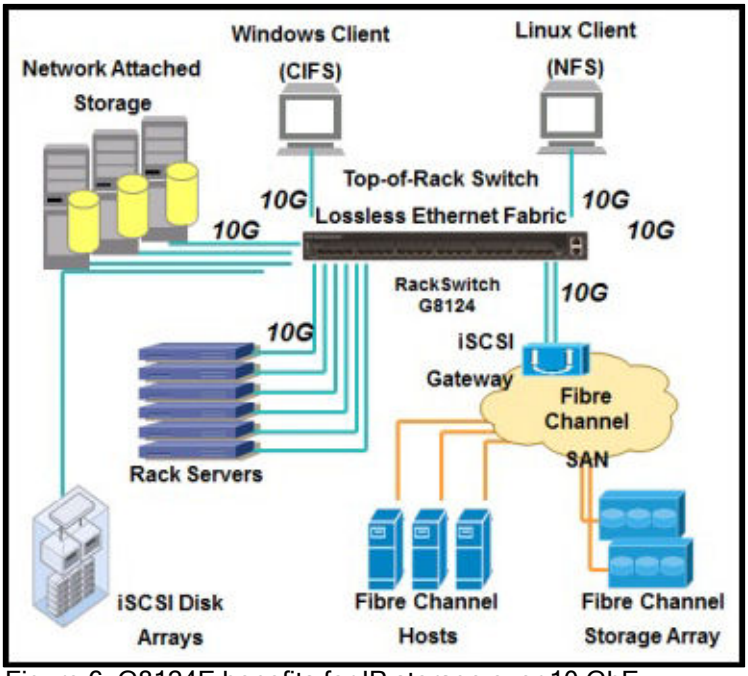

Figure 6. G8124E benefits for IP storage over 10 GbE

Related publications

For more information, visit http://www-947.ibm.com/support/entry/portal/Documentation to see the following IBM RackSwitch G8124E product resources:

- *IBM RackSwitch G8052 Installation Guide*: http://www.bladenetwork.net/userfiles/file/G8052_install.pdf
- *IBM RackSwitch G8124E isCLI Command Reference*
- *IBM RackSwitch G8124E Application Guide*
- *IBM RackSwitch G8124E Browser-Based Interface Quick Guide*
- *IBM RackSwitch G8124E Menu-Based Command Reference*

For more information, see the following resources:

- Additional Product information: http://ibm.biz/Bdx4gJ
- IBM US Announcement Letter: http://ibm.biz/Bdx4gV

Notices

This information was developed for products and services offered in the U.S.A.

IBM may not offer the products, services, or features discussed in this document in other countries. Consult your local IBM representative for information on the products and services currently available in your area. Any reference to an IBM product, program, or service is not intended to state or imply that only that IBM product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any IBM intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any non-IBM product, program, or service. IBM may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not give you any license to these patents. You can send license inquiries, in writing, to:

IBM Director of Licensing, IBM Corporation, North Castle Drive, Armonk, NY 10504-1785 U.S.A.

The following paragraph does not apply to the United Kingdom or any other country where such provisions are inconsistent with local law: INTERNATIONAL BUSINESS MACHINES CORPORATION PROVIDES THIS PUBLICATION "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some states do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to you. This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. IBM may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

Any references in this information to non-IBM Web sites are provided for convenience only and do not in any manner serve as an endorsement of those Web sites. The materials at those Web sites are not part of the materials for this IBM product and use of those Web sites is at your own risk.IBM may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation to you. Information concerning non-IBM products was obtained from the suppliers of those products, their published announcements or other publicly available sources. IBM has not tested those products and cannot confirm the accuracy of performance, compatibility or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products. This information contains examples of data and reports used in daily business operations. To illustrate them as completely as possible, the examples include the names of individuals, companies, brands, and products. All of these names are fictitious and any similarity to the names and addresses used by an actual business enterprise is entirely coincidental.

Any performance data contained herein was determined in a controlled environment. Therefore, the results obtained in other operating environments may vary significantly. Some measurements may have been made on development-level systems and there is no guarantee that these measurements will be the same on generally available systems. Furthermore, some measurement may have been estimated through extrapolation. Actual results may vary. Users of this document should verify the applicable data for their specific environment.

COPYRIGHT LICENSE:

This information contains sample application programs in source language, which illustrate programming techniques on various operating platforms. You may copy, modify, and distribute these sample programs in any form without payment to IBM, for the purposes of developing, using, marketing or distributing application programs conforming to the application programming interface for the operating platform for which the sample programs are written. These examples have not been thoroughly tested under all conditions. IBM, therefore, cannot guarantee or imply reliability, serviceability, or function of these programs.

This document was created or updated on May 10, 2013.

Send us your comments in one of the following ways:

- Use the online **Contact us** review form found at:
  ibm.com/redbooks
- Send your comments in an e-mail to:
  redbook@us.ibm.com
- Mail your comments to:
  IBM Corporation, International Technical Support Organization
  Dept. HYTD Mail Station P099
  2455 South Road
  Poughkeepsie, NY 12601-5400 U.S.A.

This document is available online at http://www.ibm.com/redbooks/abstracts/tips0787.html .

Trademarks